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Interactive comment

Interactive comment on "Graphically interpreting how incision thresholds influence topographic and scaling properties of modeled landscapes" *by* Nikos Theodoratos and James W. Kirchner

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This new paper by Theodoratos & Kirchner extends their recent developments on the dimensional analysis of landscapes at steady-state, considering here a threshold model for the stream power law. In particular, this paper offers a graphical interpretation of the findings obtained in Theodoratos & Kirchner (2020) in the form of a curvature-steepness relationship. I share most comments made by Reviewer 1 (Fiona Clubb) and do not repeat them here. Even if some redundancy exists with previous papers of the same authors, I do not find it problematic as it allows the reader to have a complete understanding of this new paper without requiring to go back and forth between these different papers. Moreover, the paper is neat and well-written and the mathematical derivations are valid. Overall, this makes this paper readily publishable after cosmetic revisions. My review could stop here.

Despite that, I feel this is a pity that this paper only considers the dimensional analysis of modeled topographies and not natural ones. I below will try to convince the authors to make some significant additions to their paper, but the editor or the authors could judge this is not necessary.

First, my main concern is that this neat and detailed analysis is made on a model which has a weak physical basis, in particular (as fairly acknowledged by the authors) due to the use of a threshold on steepness (and not on shear stress) without a stochastic description of discharge or shear stress events. In consequence, I am left to wonder what is the real addition of a paper that considers the dimensional analysis of a model with an unsupported physical basis. Second, this paper left me wondering how the steepness-curvature analysis, two metrics that are very easily measured on DEMs, resulting from this model compares with natural landscapes. Figure 3 of Perron et al. (2019; Nature) provides a nice testable (and in my opinion promising) natural example where the theoretical-graphical predictions of the authors could apply (Figure 3 shows how curvature relates to A S - and not Aˆ0.5 S - in the Gabilan Mesa first order catchments). Using this example (or another one) to demonstrate that the curvature-steepness relationship can be used to infer some potentially new constraints on K, D and U, complementary to classical steepness analysis, would clearly represent a major addition to this paper and extend the interest of this paper to a community far wider than numerical modelers. If this works well, this would also probably help answering my first point. Indeed, this would not be the first time that a geomorphological model, with little physical support, explains well natural observations (i.e. the stream power model at steady-state with S-A relationships). However, this would give a clear support (not a physical one - but an observational one) to why we need to consider a threshold, even in its simplest form, in the stream power incision law to simulate large-scale landscape evolution.

I sincerely hope these two comments will be perceived as encouragements and not as negative criticisms by the authors.

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